

## **DETAILED ACTION**

### ***Status of Application***

1. Applicant's amendments and remarks filed 3/22/2011 have been acknowledged. Claims 1, 2, 4-9, and 11-18 are pending.

The following new claim objections and grounds of rejections are being presented in response to Applicants' amendments.

### ***Claim Objections***

2. Claim 2 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 2 reciting "wherein the organic solvent used for washing is an aprotic polar solvent" is broader than the parent claim 1 which requires that the organic solvent used for washing is NMP.

### ***Claim Rejections - 35 USC § 103***

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. **Claims 1, 2, 4, 9-13, 14-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 07-330312 by Koyama et al., in view of US Patent No. 6,503,473 by Akiba.**

Regarding claims 1 and 2, Koyama et al. teach a method of producing a highly pure lithium sulfide by reacting lithium hydroxide with hydrogen sulfide in an aprotic organic solvent, and washing the lithium sulfide with an aprotic polar organic solvent such as N-methyl-2-pyrrolidone (NMP) (abstract; claims 1-2; [0035-0038]). Koyama et al. teach that the purity of the lithium sulfide is not less than 99.8% ([0036]; [0038]). The lack of mentioning of the contents of lithium N-methylaminobutyrate (LMAB) suggests that no such impurity was present (i.e. 0% by weight).

Koyama et al. do not expressly teach that the temperature of the washing solvent is 100°C or higher.

Akiba also relates to the production of lithium sulfide from a reaction between lithium hydroxide and hydrogen sulfide in an aprotic organic solvent such as NMP and teaches washing a crystal cake resulting from the reaction with the aprotic organic solvent at a temperature preferably from 50 to 120°C, for example, 100°C, in order to recover lithium hydrosulfide (abstract; column 2, lines 12-21; column 6, lines 21-28; Comparative Example 2).

It would have been obvious to one of ordinary skill in the art at time of invention to have washed lithium sulfide with NMP at a temperature of 100°C or higher in the method of Koyama et al., motivated by the fact that Akiba teaches that the viscosity of the aprotic solvent depends on the temperature and that the solubility of lithium sulfide in the aprotic organic solvent such as NMP decreases as the temperature increases over the range of 50-150°C (column 5, lines 1-45; column 6, lines 21-28). Therefore, the skilled artisan would have optimized the temperature of the washing solvent (NMP) in

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order to avoid poor washing efficiency due to the viscosity of the solvent and retain the lithium sulfide solid product while removing soluble impurities such as lithium hydrosulfide.

Regarding claims 4, 11-13, 17, and 18, Koyama et al. teach that the purity of the lithium sulfide is not less than 99.8% ([0036]; [0038]). The lack of mentioning of the contents of sulfur oxides and lithium N-methylaminobutyrate (LMAB) suggests that no such impurities were present (i.e. 0% by weight).

Regarding claim 9, the limitations of the instant claim are taught by Koyama et al. and Akiba or would have been obvious modifications of the prior arts within the ability of one of ordinary skill in the art. Koyama et al. teach reacting lithium hydroxide with hydrogen sulfide at a temperature of 0-150°C in an aprotic organic solvent to obtain a lithium sulfide; removing the aprotic organic solvent to provide a solid lithium sulfide; adding a fresh aprotic organic solvent to the solid lithium sulfide to wash the solid lithium sulfide; and drying the lithium sulfide at presumably a normal pressure ([0035-38]). Akiba teaches that solid liquid separation after the reaction is done by filtration, centrifugal separation, and the like, at a temperature preferably from 50-150°C (from column 4, line 61 to column 5, line 14). A separation technique such as centrifugal separation would have involved decantation, i.e. pouring off the solvent to separate the solid. Akiba also teaches that washing is done by dispersing the solid in an aprotic organic solvent and stirring the dispersion at a temperature preferably from 50-120°C (from column 5, line 61 to column 6, line 28). The skilled artisan would have optimized the temperature at which the aprotic organic solvent is removed and the lithium sulfide

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washed in order avoid poor washing efficiency due to the viscosity of the solvent and retain the lithium sulfide solid product while removing soluble impurities such as lithium hydrosulfide. The skilled artisan would have removed the aprotic organic solvent and dried the stirred dispersion of lithium sulfide under a stream of inert gas in order to avoid unwanted side reactions such as oxidation as Akiba suggests that oxidation could happen to produce a sulfur oxide of lithium, increasing the recovering loss of lithium compounds (column 6, lines 35-40).

Regarding claims 14, and 16, Koyama et al. teach that the organic solvent in said reacting is identical to the aprotic organic solvent for washing, i.e. NMP ([0010-11]; [0035-0038]).

Regarding claim 15, Akiba teaching washing with an aprotic organic solvent such as NMP at a temperature preferably from 50 to 120°C, for example, 100°C (column 6, lines 21-28; Comparative Example 2). This temperature is lower than the boiling temperature of the organic solvent.

**4. Claims 5-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Koyama et al. and Akiba as applied to claim 4 above, in view of US 2004/0109940 by Kugai et al.**

Regarding claims 5-8, Koyama et al. teach using lithium sulfide in the fields of electricity, electronics ([0001]).

Koyama et al. do not expressly teach a solid electrolyte for a lithium rechargeable battery comprising the lithium sulfide as per claim 5 or a solid electrolyte for a lithium

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rechargeable battery wherein the ionic conductance is  $1 \times 10^{-3}$  S/cm or higher as per claim 6.

Kugai et al. also relate to lithium sulfide ( $\text{Li}_2\text{S}$ ) and teach a solid electrolyte comprising lithium sulfide and a lithium secondary cell comprising the solid electrolyte (abstract; [0018]). Kugai et al. also teach that the solid electrolyte preferably has an ionic conductance of at least  $1 \times 10^{-4}$  S/cm, preferably from  $5 \times 10^{-4}$  S/cm to  $2.5 \times 10^{-3}$  S/cm ([0024]).

It would have been obvious to one of ordinary skill in the art at time of invention to have applied the lithium sulfide of Koyama et al. to useful applications such as a solid electrolyte and a lithium rechargeable battery comprising the electrolyte as suggested by Kugai et al. because the skilled artisan would have appreciated its properties including ionic conductance in these applications ([0006]; [0018]; [0024]).

### ***Response to Arguments and Declaration under 37 CFR 1.132***

5. Applicant's arguments filed 3/22/2011 have been fully considered but they are not persuasive. The current claims do not exclude 0% of LMAB or other impurities in the product. Lack of mentioning of these impurities in the prior arts suggest 0%, which is included in the claimed ranges.

The Declaration under 37 CFR 1.132 by Yoshikatsu Seino has been considered and found incommensurate with the scope of the claims because the experiments carried out used only one washing temperature (105 °C) within the claimed range of claim 1 (100 °C or higher) to demonstrate that the washing temperature resulted in the

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claimed content of LMAB. These experiments did not necessarily begin with the same amount of LMAB before washing so the amount of LMAB cannot be directly related to the washing temperature. The washing solvent was not even identified.

### ***Note to Applicants***

6. The Examiner has contacted Applicants' representative to propose claim amendments to place the claims in condition for allowance. For claim 1, if LMAB is claimed to be present and at 0.1% by weight or less, i.e. not 0%, the method would overcome the prior arts of record as the prior arts do not relate the washing temperature to the content of LMAB or teach the presence of LMAB as a result of the method. As Applicants attempted to demonstrate in the Declaration, the presence of LMAB is resulted from the washing of lithium sulfide at a temperature of 100°C or higher. Therefore, the Examiner suggested making claim 4, the product claim, depend on claim 1 so that the process limitations would necessarily result in a product lithium sulfide that is different from the prior arts. See MPEP 2144.04 section VII.

### ***Conclusion***

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

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the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HENG CHAN whose telephone number is (571)270-5859. The examiner can normally be reached on Monday to Friday, 9:30 am EST to 6:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer K. Michener can be reached on (571)272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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